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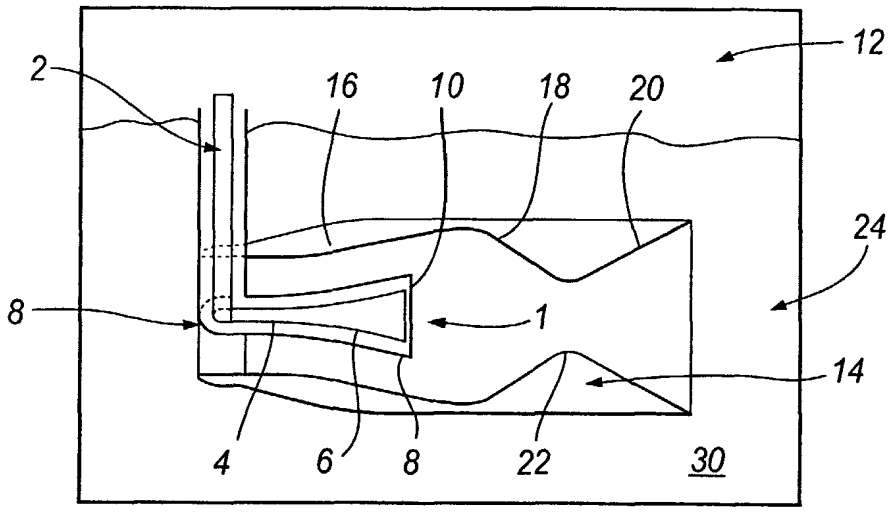
(54) Title: JET PUMP



(57) Abstract: Apparatus for generating thrust includes a steam nozzle (4) provided with a diffuser (6) encased within a secondary annular nozzle (10) which in use provides a shroud of air for emergent steam thereby to delay the implosion thereof upon contact with surrounding liquid, *e.g.* water, at a lower temperature.

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[0001] This invention concerns improvements in or relating to fluid flow generation.

[0002] Particularly, although not exclusively, the present invention has reference to such units of the kind described in our International Patent Application No PCT/AU01/00677 in which the interaction of a gas and steam projected from a nozzle arrangement gives rise to fluid flow giving a propulsive thrust sufficient to impart motion to a vessel.

[0003] It is to be understood however that units intended to generate thrust can have a variety of applications in terms of inducing flow generally and for inducing fluid movement. For example pumps could also comprise units of the kind to which the present invention is directed. In this respect, for pumping materials, *e.g.* liquids, solids, or liquids with solids suspensions, the method and apparatus described in our International Patent Application numbered as above can equally well be deployed for pumping as for propulsion.

[0004] We have now appreciated that the thrust generated in the manner described above and in the said PCT Application may be exploited in a plurality of different and differing applications.

[0005] Propulsion may thus encompass not purely the movement of a waterborne craft but may also be exploited for the purpose of forcing other objects through or within a liquid. For example in pipe cleaning the propulsive force generated by the apparatus described in that PCT Application could be used for the forced passage of cleaning rods through the pipes providing a rodding-out function to dispel material adhering to the internal surface of the pipe and impeding or adversely affecting flow. In the same vein, the use of the fluid thrust generated could be further used as a cleaning mechanism. For example, it may be a requirement to cleanse the working fluid flowing through the apparatus and in this

respect the heating effect provided by the introduction of steam may assist in this task. Moreover, cleansing may be achieved by use of the high pressure coupled with the heat provided by the steam element for cleaning the internal surfaces of pipes. Further cleaning aids for pipes could be used, for example abrasive spheres could also be employed, the thrust forcing the spheres through the pipes which would have an effect similar to shot blasting, whereby the internal surface of the pipes is scoured to remove any contaminatory deposits. The heat afforded by the steam would assist in this cleaning process.

[0006] Other applications involve the treatment of other fluids or solids by the use of the thrust generated by the method and apparatus of our co-pending UK Patent Application referred to above.

[0007] For example, other fluids or fluid materials may require treatment in which aeration, agitation or foaming is required. The jet produced by the apparatus is clearly advantageous for creating turbulence. Furthermore, the method and apparatus may be used for mixing different fluids or types of fluid or fluid/solids. Such materials may also require heat treatment and the method and apparatus may be used for this purpose in view of its provision of steam.

[0008] It is also expected that apparatus may generate or may be caused to generate noise which may in itself be of value, particularly in marine applications as a warning signal or signature of the vessel in which the apparatus is located.

[0009] The mechanism whereby this thrust is generated is the implosion of the steam occasioned by condensation thus causing an increase in velocity which in turn induces fluid flow in the surrounding environment. In marine applications the fluid flow provides the thrust thereby imparting motion to a vessel on or in which the propulsion unit is mounted.

[0010] It has been found in some cases that the condensation of the steam that brings about the implosive effect can occur very rapidly following egress of the steam from the nozzle and accordingly the interaction as between the steam and the working fluid, e.g. water, is not of sufficient duration to generate the thrust required, thus resulting in a relatively low efficiency of operation.

[0011] It is thus an object of the present invention to provide an improved apparatus and a method for the generation of thrust giving higher efficiency.

[0012] According to a first aspect of the invention apparatus for generating thrust includes a primary conduit for a hot compressible driving fluid leading to a primary nozzle including a diffuser, a secondary conduit for feeding a gas to the exterior of the nozzle and the diffuser thereby in use to provide an insulative boundary layer of gas adjacent the emergent compressible driving fluid.

[0013] Conveniently the secondary conduit surrounds the primary conduit and itself leads to an annular secondary nozzle surrounding the primary nozzle thus effectively providing a shroud for the primary nozzle.

[0014] The divergent angle of the diffuser may be variable.

[0015] The secondary nozzle may also be of variable geometry.

[0016] The primary nozzle may be of annular configuration circumscribed by the secondary nozzle thereby allowing the introduction of the insulative layer in the form of an inner stream or an outer stream, or in the form of an encompassing inner and outer stream.

[0017] There is further included in the apparatus a chamber housing or incorporating the primary and secondary nozzles. The nozzles and the chamber may be fully integrated or the nozzles may be disposed within the chamber.

[0018] The chamber is preferably contoured internally thereof in order to provide the requisite configuration to effect fluid acceleration and therefore thrust from the flow developed by the apparatus.

[0019] According to a second aspect of the invention there is provided a propulsion unit for a water borne vessel including the apparatus of the first aspect.

[0020] The propulsion unit may be incorporated within the vessel structure or may in the alternative be mounted as a separate unit thereon.

[0021] According to a third aspect of the invention there is provided a fluid mover including the apparatus of the first aspect in which the apparatus is mountable within a duct adapted to contain a liquid or a liquid flow and so arranged as in use to impart a thrust to the fluid to induce and/or enhance liquid flow.

[0022] According to a fourth aspect of the present invention there is provided a method of generating a thrust by inducing fluid flow in a body of the fluid including the steps of feeding a compressible fluid into a conduit provided with a primary nozzle having a diffuser, feeding a gas externally of the primary nozzle thereby to generate an insulative shroud of gas around the emergent compressible fluid and to delay the initial contact between the compressible fluid and the surrounding fluid body.

[0023] The invention also includes a marine vessel incorporating or including the apparatus as its propulsion system or part thereof.

[0024] The compressible fluid may be steam introduced under pressure into the conduit. The flow of gas may be induced or may be fed under pressure into the secondary conduit and to the secondary nozzle.

[0025] The method includes the step whereby the steam expands within the diffuser until the volume changes causing the pressure to equal that of the surrounding fluid body. Upon ultimate discharge of the steam from the diffuser of the primary nozzle there is condensation whereby the latent heat energy of the steam is converted into a thrust. The invention provides for the generation of a transient insulative shroud of gas, for example air, around the emergent steam thus delaying the initiation of the condensation step and allowing a higher energy utilisation than was previously possible. The condensation of the steam creates a large pressure drop and accordingly flow of fluid in the surrounding body of fluid is induced. In the particular configuration using the chamber the induced flow occasions directional thrust which in a propulsion unit is employed for moving vessels. In an alternative application the thrust generated is employed to induce flow in the manner of a pump.

[0026] It has also been found that the introduction of air or gas in this manner in the vicinity of the nozzles or indeed upstream thereof suppresses or eliminates cavitational effects thus reducing wear and noise both of which are characteristic features of cavitation. This advantage is also to be realised in the application of the invention in other modes of operation wherein the apparatus is utilised as a fluid mover. In these modes of operation the suppression of cavitation is also an important attribute.

[0027] By way of example only two embodiments of apparatus for generating thrust and a method of using said apparatus are described below with reference to the accompanying drawings in which:

[0028] Figure 1 is a diagrammatic sectional illustration of a first embodiment of the apparatus; and

[0029] Figure 2 is a diagrammatic sectional illustration of a second embodiment of the apparatus.

[0030] Referring to Figure 1 of the drawings there is shown apparatus 1 for generating a thrust including a steam conduit 2 leading to a nozzle 4 including a diffuser 6. A gas conduit 8 surrounds the conduit 2 and opens out into a passage 9 surrounding the diffuser 6 to give an annular outlet 10 for the gas. The geometry of the diffuser 6 and passage 9 may be variable and may be of varying shapes. Thus for example the diffuser and the passage may be of frusto-conical form or may be of rectilinear form in the shape of a slot. The diffuser and the passage may be formed in more than one section thus permitting the limitation on the overall length.

[0031] A steam generator (not shown) is coupled to the conduit 2 and the conduit 8 is open to the air indicated at 12 or is connected to a supply pump or cylinder (not shown).

[0032] As seen in the illustration the apparatus 1 is submerged in a liquid medium, in this example water, say sea water, and is encased in a chamber 14 which is contoured internally and as shown has a divergent inlet section 16, leading to a convergent intermediate section 18 and thence to a further divergent outlet section 20 with a narrowed orifice-like neck 22 between the sections 18 and 20, a final outlet being defined at 24.

[0033] In operation, by way of example only, the chamber 14 incorporating the apparatus 1 is mounted on a water-borne vessel as its propulsion unit and is immersed in water 30. Steam is generated in a generator (not shown), the steam being introduced into the conduit 2 for egress through nozzle 4 and the diffuser 6. At the same time air is induced or supplied through the surrounding conduit 8 which is open to the air 12 and flows through the annular space between the conduits to emerge into the passage 9 and divergent annular outlet 10. The issuance of the air from the outlet 10 generates a transient insulative shroud around the steam discharging from the diffuser 6 wherein it has expanded until the

volume change causes the pressure to equalise with that of the surrounding water 30. In view of the transient nature of the air shroud, the steam discharging through the diffuser 6 contacts the water 30 and condenses or implodes creating a large pressure drop and drawing water through the divergent section 16 of the chamber 14. The velocity of the water drawn through the chamber by virtue of the condensation of the steam is increased during its passage within the chamber and forward thrust is achieved in a direction opposite to the steam.

[0034] Referring now to Figure 2 there is shown a second embodiment of apparatus 101 including a steam conduit 102 leading to an annular nozzle 104 including a diffuser 106. A gas conduit 108 of annular form surrounds the conduit 102 and opens out into a passage 109 surrounding the diffuser 106 to give an annular outlet 110 for the gas for emergence into a mixing chamber 114. The geometry of the diffuser 106 and passage 109 may be variable and may be of varying shapes. Thus for example the diffuser and the gas passage may be of frusto-conical form or may be of rectilinear form in the shape of a slot. The diffuser and the gas passage may be formed in more than one section thus permitting the limitation on the overall length.

[0035] A steam generator (not shown) is coupled to the conduit 102 and the conduit 108 is open to atmosphere indicated at 112 or is connected to a supply pump or cylinder (not shown).

[0036] The apparatus may be submerged in a liquid medium, in this example water.

[0037] A series of gas inlet holes 120 is provided circumferentially upstream of the nozzle 104 and is adapted in this example to introduce air into the general fluid flow to give a three-phase flow to enhance the thrust.

[0038] In operation, by way of example only the apparatus 101 is mounted on a water-borne vessel as its propulsion unit and is immersed in water. Steam is

generated in the generator (not shown), the steam being introduced into the conduit 102 for egress through the nozzle 104 and the diffuser 106. At the same time air is introduced or supplied through the surrounding conduit 108 and flows through the annular space formed around the nozzle 104 and flows, in one mode of operation, over the outside and inside of the annular steam flow into its passage 109. The issuance of air from the outlet 110 generates a transient insulative shroud around the steam discharging from the diffuser 106 wherein it is expanded until the volume change causes the pressure to equalise with that of the surrounding water. In view of the transient nature of the air shroud, the steam discharging through the diffuser 106 contacts the water 30 and condenses or implodes creating large pressure drop and drawing water through the chamber 114. The velocity of the water drawn through the chamber by virtue of the condensation of the steam is increased during its passage within the chamber and forward thrust is achieved in a direction opposite to the steam.

[0039] In another mode of operation the air is used to shroud only the inner area of the issuing steam jet and in yet another mode of operation only the outer part of the issuing steam jet is subjected to the insulative effect of the incoming air. In the former, the insulative effect delays the contact between the steam and the body of water, whereas in the latter, the insulative effect delay contact between the steam and the bounding wall of the chamber 114.

[0040] A further advantage of introducing air or gas in association with the steam is that the tendency towards cavitational effects is reduced or eliminated. As will be readily appreciated by those skilled in the art cavitation has a deleterious influence upon physical structures resulting in pitting and other tribological effects with concomitant reductions in efficiency, and also cavitation can produce noise regarded as a pollutant in itself. The present invention thus affords the possibility of reducing or removing such adverse effects.

In this context also, the introduction of air or gas generally within the chamber, for example upstream of the nozzles also has a suppressant effect on cavitational effects and thus reduces the adverse influence on efficiency that cavitation causes. For this purpose air holes 120 may be provided in an appropriate manner at the selected location.

[0041] The invention thus enables an enhancement of the efficiency of the propulsion system in that it occasions the delay of the steam condensation stage by providing an insulative gas shroud for the emergent steam. Accordingly the condensation is not instantaneous upon the steam egress and is more measured allowing the full advantage of the thrust mechanism.

[0042] The thrust mechanism may also be used to generate a power stream of fluid consequent upon the energy transfer as between the compressible fluid and the working fluid passing through the apparatus. The power stream so created may be used to drive apparatus, for example to impel a rotor for the purpose of electricity generation, or indeed for any other useful purpose whereby the energy is usefully consumed.

[0043] Whilst a particularly advantageous application of the present invention lies in the field of marine propulsion, it is to be understood that the invention may have many and varied applications in the field of fluid flow. For example pumps may be adapted to incorporate the apparatus of the invention and indeed the other applications hereinbefore mentioned may also employ the present invention.

[0044] Furthermore, the present invention affords the possibility for the treatment of fluids passing through the apparatus. Accordingly the fluids may be subjected to heating by virtue of the steam input. In some applications the effect of heat in this way may reduce the viscosity of certain fluids thereby facilitating flow. In other applications it is merely the heat input that may be required in the absence of any offer effect. Agitation by virtue of the implosion of the steam gives rise to

possibilities in terms of breaking down the fluid flow where necessary and this action can be of particular importance when solids are in suspension in the stream. In particular a disintegrating effect can be realised whereby solids in suspension may be reduced in size by the energy transfer at and subsequent to the point of condensation. The solids may be inanimate in the sense that they may comprise unwanted particulates or discrete material that passes through the apparatus. Alternatively, the solids may be animate in the form of small marine life, for example arthropods including crustacea, mussels, snails, shrimp or the like, their spawn, and other invertebrates generally. The combination of heat with agitation coupled with the pressure gradient occurring in the condensation zone, can be manipulated to give the right conditions for killing marine creatures of this type. The destruction of these creatures is required to cleanse liquid waste issuing forth from vessels plying the seas; for example bilge water or ballast may contain creatures of a size that will pass through conventional mesh filters and accordingly appropriate steps need to be taken to neutralise them. It is also to be noted that some of the crustacea mentioned are sensitive to air and accordingly the present invention incorporating means for the introduction of that medium affords the facility for its utilisation in this way. The combination of heat, pressure gradient and agitation give rise to the breaking open of the carapace to expose the vulnerable flesh to the air which causes an embolism sufficient to end the creature's existence.

[0045] In a complementary vein, the present invention may be applied to kill bacteria. In waste water treatment bacteria, for example filament type bacteria, can be killed. Again the combination of heat, pressure gradient and agitation provide the destructive means for achieving this objective.

[0046] The configuration of the present invention allows the ingress of materials of a size that would ordinarily block conventional pumps or jet pumps and thus afford the opportunity to treat the through flow in the ways indicated above.

[0047] It is to be further understood that whilst the invention has been described with air as a gas for providing the shroud for the steam, any other suitable gas could be employed, for example the combustion products issuing from the boiler.

CLAIMS

1. Apparatus for generating thrust includes a primary conduit (1, 101) for a hot compressible driving fluid leading to a primary nozzle (4, 104) including a diffuser (6, 106), **characterised by** a secondary conduit (8, 108) for feeding a gas to the exterior of the nozzle (4, 104) and the diffuser (6, 106) thereby in use to provide an insulative boundary layer of gas around the emergent compressible driving fluid.

2. Apparatus according to Claim 1 **characterised in that** the secondary conduit (8, 108) surrounds the primary conduit (1, 101) and itself leads to an annular secondary nozzle (10, 110) surrounding the primary nozzle (4, 104) thus effectively providing a shroud for the primary nozzle (4, 104).

3. Apparatus according to Claim 1 **characterised in that** the primary nozzle (104) is of annular form.

4. Apparatus according to any one of the preceding claims **characterised in that** the divergent angle of the diffuser (6, 106) is variable.

5. Apparatus according to any one of the preceding claims **characterised in that** the secondary nozzle (10, 110) is of variable geometry.

6. Apparatus according to any one of the preceding claims **characterised in that** there is provided a chamber housing (14, 114) for incorporating the primary and secondary nozzles (4, 110).

7. Apparatus according to Claim 6 **characterised in that** the nozzles (4, 104, 10, 110) and the chamber (14, 114) are fully integrated.

8. Apparatus according to Claim 6 **characterised in that** the nozzles (4, 104, 10, 110) are disposed within the chamber (14, 114).

9. Apparatus according to any one of Claims 6 to 8 **in which** the chamber (14, 114) is contoured internally.

10. Apparatus according to Claim 8 or 9 **characterised in that** the internal geometry of the chamber (14, 114) is variable.

11. A propulsion unit **characterised by** apparatus (1, 101) for generating thrust according to any one of the preceding claims.

12. A water-borne vessel **characterised by** a propulsion unit according to Claim 11.

13. A fluid mover **characterised by** apparatus (1, 101) according to any one of the preceding Claims 1 to 10.

14. A fluid mover according to Claim 13 **characterised in that** the fluid mover is a pump.

15. A fluid mover according to Claim 13 or 14 **characterised in that** the fluid mover is mountable within a duct adapted to contain a liquid or a liquid flow whereby the mover is so arranged as to impart thrust to the liquid to enhance or induce liquid flow.

16. A method of generating thrust by inducing fluid flow in a body of the fluid including the steps of feeding a compressible fluid into a conduit (2, 102) provided with a primary nozzle (4, 104) having a diffuser (6, 106), **characterised by** feeding a gas externally of the primary nozzle (4, 104) to generate an insulative shroud of gas around the emergent compressible fluid

and to delay the initial contact between the compressible fluid and the surrounding fluid body.

17. A method according to Claim 15 **characterised in that** the insulative shroud of gas around the emergent compressible fluid serves to suppress cavitation.

18. A method according to Claim 15 or 16 **characterised in that** air or gas is injected into the body of the fluid upstream or downstream of the introduction of the compressible fluid to suppress cavitational effects.

19. A method according to Claim 15, 16 or 17 **characterised in that** the compressible fluid is steam.

20. A method according to any one of the preceding claims 15 to 19 **characterised in that** the gas is air.

21. A method according to Claim 15 **characterised in that** the thrust generated is employed as a disintegrating mechanism for solids materials passing through the apparatus.

22. A method according to any one of the preceding Claims 19 or 20 **characterised in that** the method is employed to kill bacteria, wherein the bacteria are subjected to heat, agitation and a pressure gradient.

23. A method according to Claim 19 characterised **in that** the method is employed to heat a fluid.

24. A method according to Claim 19 **characterised in that** the method is employed for aeration.

25. A method according to Claim 19 **characterised in that** the method is employed for mixing.

26. A method according to Claim 19 **characterised in that** the method is employed for agitation.

AMENDED CLAIMS

[received by the International Bureau on 11 August 2003 (11.08.03);
original claims 1-26 replaced by new claims 1-29]

1. Apparatus for generating thrust includes a primary conduit (1, 101) for a hot compressible driving fluid leading to a primary nozzle (4, 104) including a diffuser (6, 106), **characterised by** a secondary conduit (8, 108) for feeding a gas to the exterior of the nozzle (4, 104) and the diffuser (6, 106) thereby in use to provide an insulative layer of gas at a boundary of the emergent compressible driving fluid.

2. Apparatus according to Claim 1 **characterised in that** the secondary conduit (8, 108) surrounds the primary conduit (1, 101) and itself leads to an annular secondary nozzle (10, 110) surrounding the primary nozzle (4, 104) thus effectively providing a shroud for the primary nozzle (4, 104).

3. Apparatus according to Claim 1 or 2 **characterised in that** the primary nozzle (104) is of annular form.

4. Apparatus according to Claim 3 **characterised in that** the secondary conduit is located such that the insulative layer is formed at the exterior boundary of the emergent compressible driving fluid.

5. Apparatus according to Claim 3 **characterised in that** the secondary conduit is located such that the insulative layer is formed at the interior boundary of the emergent compressible driving fluid.

6. Apparatus according to Claim 3 **characterised in that** the secondary conduit is located such that the insulative layer is formed at the interior and exterior boundaries of the emergent compressible driving fluid.

7. Apparatus according to any one of the preceding claims **characterised in that** the divergent angle of the diffuser (6, 106) is variable.

8. Apparatus according to any one of the preceding claims **characterised in that** the secondary nozzle (10, 110) is of variable geometry.

9. Apparatus according to any one of the preceding claims **characterised in that** there is provided a chamber housing (14, 114) for incorporating the primary and secondary nozzles (4, 110).

10. Apparatus according to Claim 9 **characterised in that** the nozzles (4, 104, 10, 110) and the chamber (14, 114) are fully integrated.

11. Apparatus according to Claim 9 **characterised in that** the nozzles (4, 104, 10, 110) are disposed within the chamber (14, 114).

12. Apparatus according to any one of Claims 9 to 11 **in which** the chamber (14, 114) is contoured internally.

13. Apparatus according to Claim 11 or 12 **characterised in that** the internal geometry of the chamber (14, 114) is variable.

14. A propulsion unit **characterised by** apparatus (1, 101) for generating thrust according to any one of the preceding claims.

15. A water-borne vessel **characterised by** a propulsion unit according to Claim 14.

16. A fluid mover **characterised by** apparatus (1, 101) according to any one of the preceding Claims 1 to 10.

17. A fluid mover according to Claim 16 **characterised in that** the fluid mover is a pump.

18. A fluid mover according to Claim 16 or 17 **characterised in that** the fluid mover is mountable within a duct adapted to contain a liquid or a liquid flow whereby the mover is so arranged as to impart thrust to the liquid to enhance or induce liquid flow.

19. A method of generating thrust by inducing fluid flow in a body of the fluid including the steps of feeding a compressible fluid into a conduit (2, 102) provided with a primary nozzle (4, 104) having a diffuser (6, 106), **characterised by** feeding a gas externally of the primary nozzle (4, 104) to generate an insulative shroud of gas at a boundary of the emergent compressible fluid and to delay the initial contact between the compressible fluid and the surrounding fluid body.

20. A method according to Claim 19 **characterised in that** the insulative shroud of gas around the emergent compressible fluid serves to suppress cavitation.

21. A method according to Claim 19 or 20 **characterised in that** air or gas is injected into the body of the fluid upstream or downstream of the introduction of the compressible fluid to suppress cavitational effects.

22. A method according to Claim 19, 20 or 21 **characterised in that** the compressible fluid is steam.

23. A method according to any one of the preceding claims 19 to 22 **characterised in that** the gas is air.

24. A method according to Claims 19, 22 or 23 **characterised in that** the mechanism for generating thrust is employed as a disintegrating mechanism for solids materials passing through the apparatus.

25. A method according to any one of the preceding Claims 22 or 23 **characterised in that** the method is employed to kill bacteria, wherein the bacteria are subjected to heat, agitation and a pressure gradient.

26. A method according to Claim 22 characterised **in that** the mechanism for generating thrust is employed to heat a fluid, fluids, or fluid/solids.

27. A method according to Claim 22 **characterised in that** the mechanism for generating thrust is employed for aeration.

28. A method according to Claim 22 **characterised in that** the mechanism for generation thrust is employed for mixing.

29. A method according to Claim 22 **characterised in that** the mechanism for generating thrust is employed for agitation.

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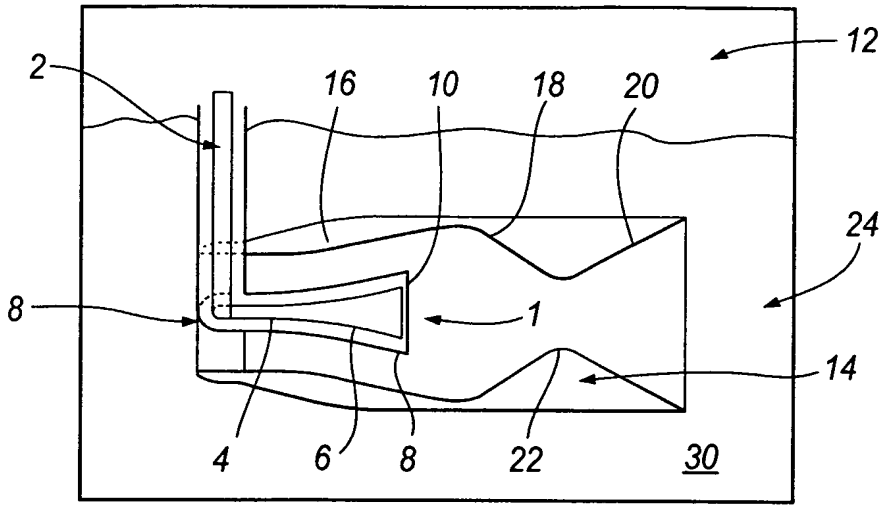
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Fig.1

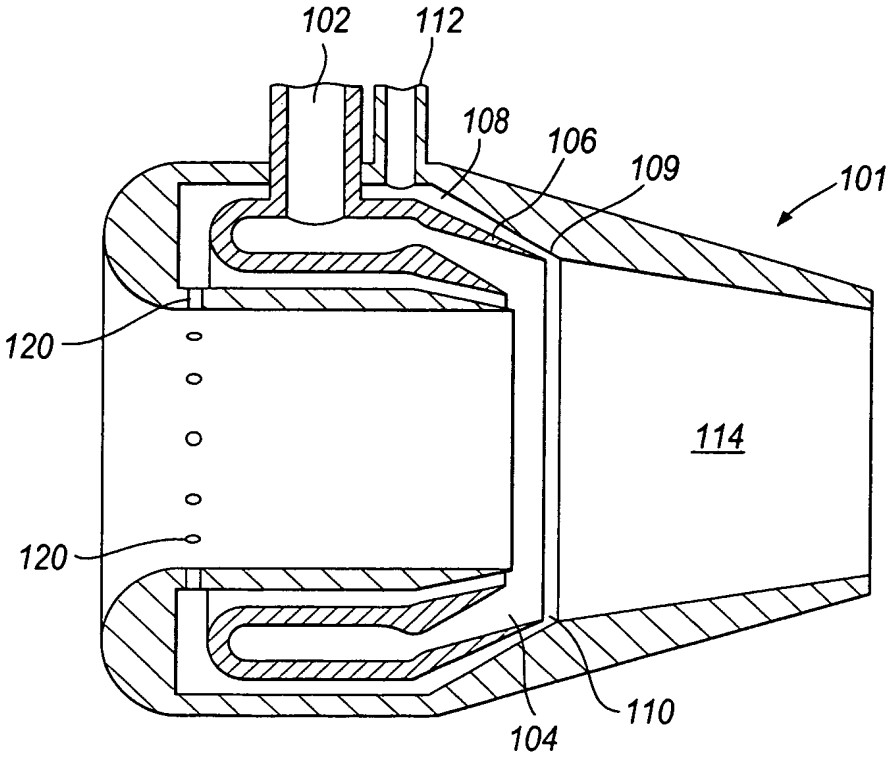
102
112
108
106
109
101
120
114
120
104
110

Fig.2

INTERNATIONAL SEARCH REPORT

Int[illegible]onal Application No
PCT/GB 03/00809

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F04F5/14 F04F5/24 F02K7/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F04F F02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 189 843 A (PRINGLE JAMES MAITLAND) 4 November 1987 (1987-11-04) the whole document	1-3,6-9, 14-18, 25,26
Y		4,5, 10-13, 19-24

Y	WO 01 94197 A (BURNS ALAN ROBERT ;PURSUIT DYNAMICS PLC (GB)) 13 December 2001 (2001-12-13) cited in the application Breakdown:	4,5, 10-13, 19,20
Y	claims 42-47	4,10
Y	claims 32,36	5
Y	claims 1,49	11-13
Y	claims 9,10,17	19,20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
30 June 2003	07/07/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Criado Jimenez, F

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